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Commission

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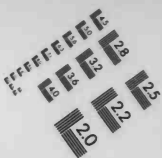
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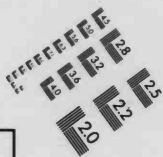
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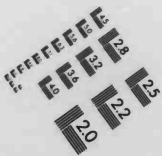
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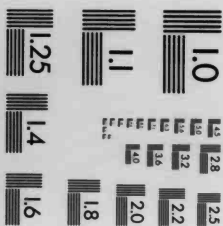
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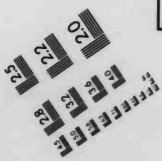
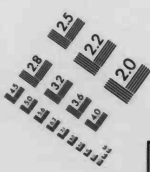
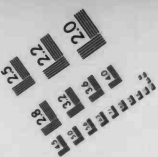
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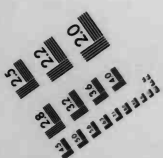
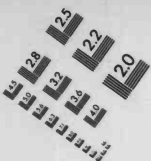
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NATURAL GAS COMPANY PLANT INVESTIGATION
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NATURAL GAS COMPANY PLANT INVESTMENT UNITS

This report presents a series of studies of natural gas company plant investment. For convenience in discussion and for reference purposes it is divided into the following sections:

- Section 1 Transmission Plant Investment. Pipe lines, compressor stations, measuring and regulating stations, and land are treated separately in subsections (a), (b), (c), and (d), respectively.
- Section 2 Production Plant Investment. Field lines and field compressor stations are treated separately in subsections (a) and (b), respectively.
- Section 3 Distribution Plant Investment. Mains, services, meters, and other important classes of distribution plant are treated separately and in total.
- Section 4 General Plant Investment.

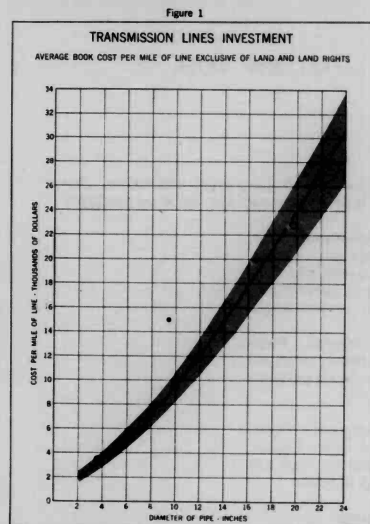
On the following pages are brief discussions of each of the subjects included in the above enumerated sections. Included in each discussion are figures and tables pertaining to the respective subject.

The studies are based upon data reported to the Federal Power Commission by Class A and Class B natural gas companies for the year 1945. Data included in individual sections have been limited to those which appear to be fully and accurately presented in the company reports. The studies, therefore, constitute an assembly and analysis of data as reported without adjustments or introduction of estimates.

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SECTION I TRANSMISSION PLANT INVESTMENT

(a) Transmission Lines - The average book cost of transmission pipe lines, exclusive of land and land rights, ranges from approximately \$3,400 per mile for lines of 4-inch diameter to approximately \$30,000 per mile for



lines of 24-inch diameter. Comparison of these costs and costs of lines of intermediate diameters discloses that, generally, as the diameter of pipe increases the cost per mile of line increases somewhat more than proportionately.

Current construction costs are, of course, considerably higher than the average book costs cited above which represent average construction costs of lines completed prior to 1946. Average costs of lines for which certificates of public convenience and necessity were granted by the Commission during the years 1945 and 1946 are expected to be generally about 50 percent higher than the average costs of lines now in operation. Estimated costs of the proposed lines are discussed in more detail in a subsequent paragraph.

In Figure 1 are shown average book costs per mile of line for transmission lines of various diameters. The central curve in the figure indicates the average unit costs of all lines included in the study. The outer limits of the shaded area represent the average unit costs of lines costing more than and of lines costing less than the average of all lines. Table I contains the data on which the curves in the figure are based.

By reference to Figure 1, the increase in average costs per mile of line as the diameter of line increases may be observed. For example, readings from the central curve show that average costs per mile of line increase from approximately \$3,400 per mile for 4-inch lines to approximately \$17,700 per mile for 16-inch lines. The relative increase in average costs per mile of line as diameter of line increases becomes more apparent when costs per inch of diameter per mile of line are computed. Using the above readings as illustrations, the average cost per inch of diameter per mile of 4-inch lines is approximately \$850 and for 16-inch lines such average cost is approximately \$1,100. This trend towards higher average costs per inch of diameter per mile of line continues as the diameter of line increases. Under four inches, however, a contradictory trend will be observed, 3-inch lines costing on the average slightly more per inch of diameter per mile than 4-inch lines, and 2-inch lines costing as much per inch of diameter per mile as 12-inch lines. Approximate readings from the central curve in the figure and computed costs per inch of diameter per mile of line are shown below.

Diameter of Pipe Inches	Cost Per Mile of Line	Cost Per Inch of Diameter Per Mile of Line
2	\$ 2,000	\$1,000
3	2,000	800
4	3,400	850
8	7,100	880
12	12,000	1,000
16	17,700	1,100
20	24,000	1,200
24	30,000	1,300

In the preceding discussion the effect of size of pipe upon the cost of pipe lines has been considered. However, other factors such as topography and character of soil of the region through which the pipe line passes, kind of pipe employed, year constructed, expected operating pressures

and economy of construction effect variations in unit costs of pipe lines of the same size. Therefore, it is of interest to examine the extent to which these unit costs vary. Referring again to Figure 1, it will be noted that average costs per mile for lines costing more than the average of all lines range from \$4,200 for 4-inch lines to \$34,000 for 24-inch lines. For lines costing less than the average of all lines, average costs per mile range from \$2,800 for 4-inch lines to \$26,200 for 24-inch lines. For both groups of lines, average deviations from the central curve vary from approximately 20% for 4 to 8-inch lines to only about 12% for 12 to 24-inch lines. Average unit costs of the higher cost lines of from 4 to 8 inches in diameter are approximately 50% higher than those of the lower cost lines, and for lines of from 12 to 24 inches in diameter the difference is approximately 30%.

As indicated previously, the average book costs described above do not reflect current high material and labor costs. In the following tabulation are shown results of an analysis of estimated construction costs contained in applications filed with the Commission for certificates of public convenience and necessity authorizing the construction of approximately 5,600 miles of pipe lines. These applications were filed with and approved by the Commission during the years 1945 and 1946. It will be noted that the expected effect of prevailing price levels upon pipe line costs is

considerable. Average estimated costs range from approximately \$4,000 per mile for 4-inch lines to approximately \$45,000 per mile for 26-inch lines. Percentage increases in these estimated costs, based upon 1945 and 1946 price levels, over present book costs range from approximately 30% for 24-inch lines to approximately 75% for 4-inch lines.

Average Estimated Costs, 1945 - 1946			
Diameter of Pipe Inches	Per Mile of Line	Per Inch of Diameter Per Mile of Line	Percent Increase Over Average Book Costs
4	\$ 6,000	\$1,500	75
8	12,000	1,500	65
12	18,500	1,540	55
16	25,000	1,560	45
20	33,000	1,650	35
24	41,000	1,700	30
26	45,000	1,725	

Average book costs discussed in this study are based upon data reported for approximately 22,000 miles of transmission pipe lines constituting an investment on the books of the reporting companies in excess of \$222,000,000. Included in the study are two classes of cost data; costs of individual lines, and costs of groups of lines of various diameters where length and diameter of lines comprising the groups are specified. In the latter case, the weighted average diameter of each group of lines was computed and a curve reflecting the relation between costs per mile and diameters compared to a similar curve based upon costs of individual lines. It was found that the two curves were virtually identical.

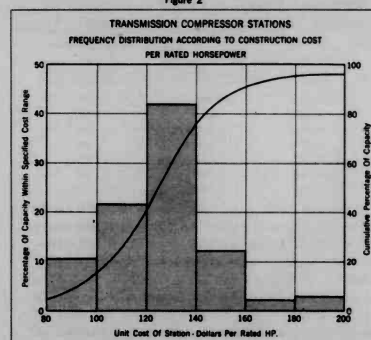
TABLE I
TRANSMISSION LINES INVESTMENT
BOOK COST PER MILE EXCLUSIVE OF LAND AND LAND RIGHTS

DIAMETER OF PIPE (Inches)	MILES OF LINES	WEIGHTED AVERAGE DIAMETER OF PIPE (Inches)	BOOK COST OF LINES	
			AMOUNT	PER MILE
ALL LINES				
0.0 - 4.0	237.3	3.6	\$ 823,547	\$ 3,470
4.1 - 8.0	12,857.6	7.2	77,166,721	6,000
8.1 - 12.0	4,666.3	10.0	46,254,840	9,507
12.1 - 16.0	1,596.7	14.3	25,931,567	16,220
16.1 - 20.0	721.7	19.7	16,462,652	22,811
20.1 - 24.0	2,025.5	22.6	57,227,287	28,109
TOTAL	22,137.5	10.1	\$222,166,574	\$10,035
LINES COSTING MORE THAN AVERAGE				
0.0 - 4.0	190.6	3.6	\$ 732,806	\$ 3,845
4.1 - 8.0	3,044.6	6.6	21,534,478	7,027
8.1 - 12.0	1,851.6	9.5	19,761,812	10,661
12.1 - 16.0	1,430.9	14.3	23,570,407	16,472
16.1 - 20.0	320.6	19.7	6,852,656	21,413
20.1 - 24.0	1,673.9	22.6	49,283,190	29,462
TOTAL	8,532.4	12.1	\$123,715,353	\$14,499
LINES COSTING LESS THAN AVERAGE				
0.0 - 4.0	46.7	3.5	\$ 90,739	\$ 1,943
4.1 - 8.0	9,793.0	7.4	55,612,293	5,679
8.1 - 12.0	2,836.5	10.3	28,413,028	8,758
12.1 - 16.0	167.8	14.5	2,361,160	14,071
16.1 - 20.0	401.1	18.6	7,409,994	18,473
20.1 - 24.0	362.0	22.9	7,944,057	21,945
TOTAL	13,605.1	8.8	\$ 98,431,221	\$ 7,235

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

(b) Transmission Compressor Stations - The average book cost, exclusive of land, of transmission compressor stations amounts to approximately \$130 per horsepower. Although conditions affecting the cost of these stations vary widely and

Figure 2



are reflected in individual instances of extremely low and extremely high unit costs, there is a marked concentration of station costs around the over-all average.

During the current period of high material and labor costs, compressor station costs are expected to be considerably higher, of course, than the average book costs cited above. In applications filed with the Commission during the years 1945 and 1946 for certificates of public convenience and necessity, estimated construction costs of the proposed new stations average approximately \$190 per horsepower. These estimated costs are discussed further in a subsequent paragraph.

In Figure 2, which describes costs of stations placed in operation prior to 1946, there are shown by means of vertical bars the respective percentages of the total capacity of the stations, as measured by total rated horsepower of all driving units, falling within designated ranges of costs per horsepower. The same information is shown cumulatively in the curve appearing in the figure. Data on stations costing less than \$80 per horsepower and more than \$200 per horsepower are omitted for convenience but are included in Table 2 which contains all data used in the preparation of the figure.

It will be observed that the most generally prevailing costs are between \$120 and \$140 per horsepower. In excess of 40% of the total capacity is represented in this interval. The second largest proportion occurs in the group of stations costing from \$100 to \$120 per horsepower. In these two groups, that is, in stations costing from \$100 to \$140 per horsepower, are included approximately 65% of the total capacity. Referring to the cumulative curve, it will be noted that the median cost per horsepower is approximately \$125 and that in the central 50% of the data, costs range from approximately \$110 per horsepower to approximately \$140 per horsepower.

In marked contrast to the general concentration of unit costs are the wide variations from the median cost found at the extremes of the frequency distribution. These extreme costs are generally the result of construction conditions where the principal factors controlling costs are all of either high cost influence or of low cost influence. For example, certain low cost stations employ equipment not new when installed, are situated in locations relatively accessible, are medium size stations of simple design, and were constructed during a period of low material and labor costs. Several high cost stations are of elaborate design, are situated in locations relatively remote, and were constructed during years when material and labor costs were high.

The effects of station size and of price levels, as indicated by year of installation, upon unit costs of compressor stations are considered in the following discussion. However, exact quantitative measurement of the effect of these factors is precluded by the presence of other conditions surrounding the construction of individual stations on which information is limited or not available.

With respect to size of station, it is found, as shown in the following tabulation, that the average unit cost of small stations of 500 horsepower or less is somewhat higher than average unit costs of larger stations. It will be noted, however, that there is little further tendency towards lower unit costs as station size increases beyond 500 horsepower. Average unit costs of stations of from 500 to 1,000 horsepower and of stations of more than 10,000 horsepower are approximately the same. Also shown in the following tabulation are average unit costs of structures and improvements and of equipment. Comparison of these costs discloses that of the total

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

cost of stations, exclusive of land, they represent approximately 20 percent and 80 percent, respectively.

Interval Size of Station Rated HP	Number Of Stations	Average Cost per Horsepower		
		Structures & Improvements	Equipment	Total
0 - 500	20	\$30	\$105	\$135
501 - 1,000	31	25	100	125
1,001 - 2,500	30	21	97	118
2,501 - 5,000	28	20	100	120
5,001 - 10,000	31	20	100	120
Over 10,000	16	20	105	125
TOTAL	174	\$26	\$102	\$128

For determination of the effect of price levels upon unit costs, the stations were classified into four groups, stations placed in operation during the years 1907 to 1917 and the years 1930 to 1935, periods of generally low price levels, and stations placed in operation during the years 1918 to 1929 and the years 1936 to 1945, periods of generally high price levels. As shown in the following tabulation, the average unit cost of stations placed in operation prior to 1918 is somewhat lower than the average unit costs of all other stations. It will be recognized, however, that station design prior to 1918 was not as elaborate as in later years and that the lower unit costs of these stations reflect their relatively simple design as well as the influence of lower price levels.

Interval Period Station Placed in Operation	Number of Stations	Average Cost Per Horsepower		
		Structures & Improvements	Equipment	Total
1907 - 1917	37	\$16	\$ 87	\$103
1918 - 1929	54	25	108	133
1930 - 1935	27	31	99	130
1936 - 1945	56	27	106	133
Total	174	\$26	\$102	\$128

The effect of unusually high price levels such as exist currently is reflected in the estimated costs of stations for which certificates of public convenience and necessity were filed with and approved by the Commission during the years 1945 and 1946. The expected median cost of these stations, based upon the total contemplated capacity, is \$190 per horsepower. In the central 50% of the data, costs range from \$170 per horsepower to \$210 per horsepower.

Average book costs discussed in this study are based upon data reported for 174 transmission compressor stations constituting an investment on the books of the reporting companies in excess of \$84,000,000. Total rated horsepower of all driving units of these stations is in excess of 650,000 horsepower.

TABLE 2
TRANSMISSION COMPRESSOR STATIONS
FREQUENCY DISTRIBUTION ACCORDING TO CONSTRUCTION COST
PER RATED HORSEPOWER

INTERVAL DOLLARS PER RATED HP	NUMBER OF STATIONS	TOTAL BOOK COST EXCLUSIVE OF LAND	TOTAL RATED HORSEPOWER OF STATIONS		
			AMOUNT	PERCENT OF TOTAL	CUMULATIVE PERCENT
40 - 60	5	\$ 430,121	7,750	1.2	1.2
61 - 80	14	1,776,533	24,000	3.6	4.8
81 - 100	26	6,581,368	69,769	10.6	15.4
101 - 120	31	15,493,917	141,845	21.6	37.0
121 - 140	50	35,463,494	275,141	41.8	78.8
141 - 160	23	12,080,028	79,769	12.1	90.9
161 - 180	7	2,396,302	13,710	2.1	93.0
181 - 200	4	3,509,036	19,170	2.9	95.9
201 - 220	8	3,012,548	14,635	2.2	98.1
221 - 320	6	3,387,102	12,610	1.9	100.0
TOTAL	174	\$84,130,469	658,399	100.0	

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

(c) Transmission Measuring and Regulating Stations - Investment in transmission measuring and regulating stations constitutes an extremely small proportion of the total investment in transmission plant, the average ratio of investment in such stations to total transmission plant investment amounting to approximately six-tenths of one percent. In approximately 90% of the data, as measured by the total investment in transmission plant of all companies included in the study, this ratio of investment in measuring and regulating stations to total transmission plant investment is less than 1.6%. In the central 50% of the data, such ratios vary from 0.2% to 0.8%, the median ratio being 0.4%. The lowest ratio and highest ratio displayed are, respectively, 0.04% and 1.93%. These data are based upon the frequency distribution table presented below.

Lack of data on the capacity of transmission measuring and regulating stations prevents an expression of average costs on a capacity basis. With respect to total costs, individual stations vary widely, ranging from approximately \$100 per station to over \$20,000 per station, depending upon, among many factors, the pressure and rate of flow of gas passed through the station.

Costs of measuring and regulating stations include the costs of structures and station equipment. The cost of land is not included.

This study is based upon the reports of 35 companies having a combined investment in total transmission plant of approximately \$360,000,000. Combined investment, exclusive of investment in land, in transmission measuring and regulating stations of these companies amounts to slightly in excess of \$2,100,000.

TABLE 3
TRANSMISSION MEASURING AND REGULATING STATIONS
FREQUENCY DISTRIBUTION ACCORDING TO CONSTRUCTION COST AS A
PERCENT OF COST OF TOTAL TRANSMISSION PLANT

INTERVAL COST OF TRANSMISSION MEASURING & REGULATING STATIONS PERCENT OF COST OF TOTAL TRANSMISSION PLANT	NUMBER OF COMPANIES	BOOK COST OF MEASURING & REGULATING STATIONS EXCLUSIVE OF LAND	TOTAL BOOK COST OF TRANSMISSION PLANT		
			AMOUNT	PERCENT OF TOTAL	CUMULATIVE PERCENT
0.00 - 0.20	3	\$ 88,485	\$ 80,215,666	22.3	22.3
0.21 - 0.40	9	272,301	102,590,055	28.5	50.8
0.41 - 0.60	6	304,607	66,628,625	18.5	69.3
0.61 - 0.80	3	145,379	20,617,162	5.7	75.0
0.81 - 1.00	4	79,524	8,744,871	2.4	77.4
1.01 - 1.20	2	286,124	24,657,296	6.8	84.2
1.21 - 1.40	4	164,450	12,119,697	3.4	87.6
1.41 - 2.00	2	765,295	44,760,107	12.4	100.0
TOTAL	35	\$2,108,165	\$360,333,479	100.0	

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

(d) Transmission Plant Land and Land Rights - Although investment in transmission plant land and land rights varies widely among individual companies, the proportion of such investment to total investment in transmission plant is, in all instances, relatively small. The overall average ratio of land investment to total transmission plant investment amounts to only 2.7%.

Referring to the frequency distribution table presented below, it will be observed that the most generally prevailing ratios of investment in transmission plant land to investment in total transmission plant range from 1.0% to 3.0%. Com-

panies displaying ratios within these limits account for approximately 60% of the total investment in transmission plant represented in the study. The lowest ratio and highest ratio displayed are respectively 0.1% and 7.6%. Ratios greater than 5% occur in less than 2% of the total transmission plant investment represented.

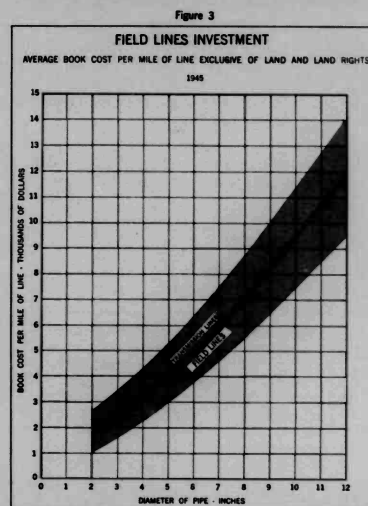
This study is based upon the reports of 55 companies having a combined investment in total transmission plant of approximately \$469,000,000. Combined investment in transmission plant land and land rights of these companies amounts to approximately \$12,700,000.

TABLE 4
TRANSMISSION PLANT LAND AND LAND RIGHTS
FREQUENCY DISTRIBUTION ACCORDING TO COST OF LAND AND
LAND RIGHTS AS A PERCENT OF COST OF TOTAL TRANSMISSION PLANT

INTERVAL COST OF TRANSMISSION LAND & LAND RIGHTS % OF COST OF TOTAL TRANSMISSION PLANT	NUMBER OF COMPANIES	BOOK COST OF TRANSMISSION PLANT LAND & LAND RIGHTS	TOTAL BOOK COST OF TRANSMISSION PLANT		
			AMOUNT	PERCENT OF TOTAL	CUMULATIVE PERCENT
0.00 - 1.00	8	\$ 135,676	\$ 21,869,927	4.7	4.7
1.01 - 2.00	14	2,164,960	143,930,286	30.7	35.4
2.01 - 3.00	16	3,268,645	128,841,157	27.5	62.9
3.01 - 4.00	6	2,672,821	78,975,014	16.8	79.7
4.01 - 5.00	6	3,964,041	86,487,405	18.4	98.1
5.01 - 8.00	5	519,269	8,689,159	1.9	100.0
TOTAL	55	\$12,725,412	\$468,792,948	100.0	

SECTION 2 PRODUCTION PLANT INVESTMENT

(a) Field Lines - Average investment in field lines, exclusive of investment in land and land rights, ranges from approximately \$1,700 per mile for lines of 2-inch diameter to approximately \$11,900 per mile for lines of 12-inch diameter.



meter. As in the case of transmission lines, there is generally a slightly more than proportional increase in the average investment per mile of line as the diameter of line increases.

In Figure 3 are shown average book costs per mile of line for field lines of various diameters. The curve labeled field lines represents the average unit costs of all field lines included in the study. The outer limits of the shaded area represent the average unit costs of lines costing more and of lines costing less than the average of all lines. Data used in preparation of the figure are contained in Table 5. For purposes of comparison, average unit costs of transmission lines of from two to twelve inches in diameter are also shown in Figure 2. These costs are discussed in detail in Section 1 of the report.

By reference to the figure, the increase in average costs per mile of line as the diameter of line increases may be observed. For example, approximate readings from the curve labeled field lines show that average costs per mile of line increase from \$3,000 for 4-inch lines to \$7,000 for 8-inch lines. It will also be noted that there is but little difference between costs of field lines and costs of transmission lines of equal diameters. For lines over eight inches in diameter, differences are hardly measurable; under eight inches the slightly lower average costs of field lines become more apparent. Under four inches, costs of field lines are on the average approximately \$300 less per mile of line than costs of transmission lines of like diameters. Approximate readings from the curve labeled field lines and computed costs per inch of diameter per mile of line are shown below.

Diameter of Pipe Inches	Cost per Mile of Line	Cost per Inch of Diameter Per Mile of Line
2	\$ 1,700	\$ 850
3	2,900	800
4	3,000	750
6	4,800	800
8	7,000	800
10	9,900	990
12	11,900	1,000

Variations in unit costs of field lines of the same diameter reflect the considerable differences in conditions surrounding construction of the lines. By reference to the upper limit and lower limit of the shaded area in the accompanying figure, some measure of the total effect upon unit costs of such variables as topography, expected operating pressures, and economy of construction may be ascertained. As will be observed, average costs of lines costing more than the average of all lines range from approximately \$3,000 per mile for lines of from two to four inches in diameter to \$13,000 per mile for ten to twelve inch lines. These costs are approximately 20 percent higher than the average costs of all lines. For lines costing less than the average of all lines, average costs range from approximately \$1,500 per mile for two to four inch lines to approximately \$9,000 per mile for ten to twelve inch lines. Such costs are generally about 25 percent lower than the average costs of all lines. Average unit costs of high cost lines are generally about 70 percent higher than average unit costs of low cost lines.

Included in this study are two classes of cost data; costs of individual lines and costs of groups of lines of various diameters where length and diameter of lines comprising the groups are specified. In the latter case, the weighted average diameter of each group of lines was computed and a curve reflecting the relation between average costs per mile and diameter compared

to a similar curve based upon costs of individual lines. It was found that the two curves were virtually identical.

This study is based upon data reported for approximately 17,000 miles of field lines constituting an investment on the books of the reporting companies of approximately \$72,000,000.

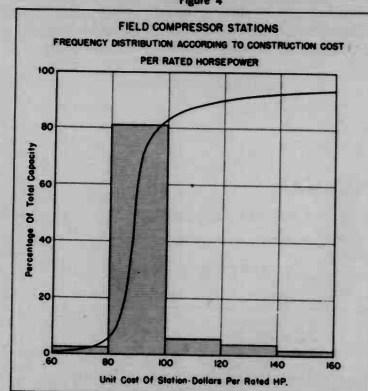
TABLE 5
FIELD LINES INVESTMENT
BOOK COST PER MILE OF LINE EXCLUSIVE OF LAND AND LAND RIGHTS

DIAMETER OF PIPE (Inches)	MILES OF LINES	WEIGHTED AVERAGE DIAMETER OF PIPE (Inches)	BOOK COST OF LINES	
			AMOUNT	PER MILE
ALL LINES				
0.0 - 4.0	4,762.8	3.4	\$11,998,548	\$ 2,519
4.1 - 6.0	9,998.1	5.1	39,979,833	3,999
6.1 - 8.0	1,691.8	6.8	11,970,301	7,075
8.1 - 10.0	361.9	8.5	2,573,881	7,112
10.1 - 12.0	<u>485.7</u>	<u>11.2</u>	<u>5,228,104</u>	<u>10,764</u>
TOTAL	17,300.3	5.1	\$71,750,667	\$ 4,147
LINES COSTING MORE THAN AVERAGE				
0.0 - 4.0	1,280.3	3.0	\$ 3,274,767	\$ 2,558
4.1 - 6.0	4,305.3	5.1	22,918,731	5,323
6.1 - 8.0	1,272.4	6.7	9,745,983	7,660
8.1 - 10.0	155.1	8.8	1,569,682	10,120
10.1 - 12.0	<u>313.1</u>	<u>11.3</u>	<u>4,002,786</u>	<u>12,784</u>
TOTAL	7,326.2	5.3	\$41,511,949	\$ 5,666
LINES COSTING LESS THAN AVERAGE				
0.0 - 4.0	3,482.5	3.6	\$ 8,723,781	\$ 2,505
4.1 - 6.0	5,692.8	5.2	17,061,102	2,997
6.1 - 8.0	419.4	7.0	2,224,318	5,304
8.1 - 10.0	206.8	8.4	1,004,199	4,856
10.1 - 12.0	<u>172.6</u>	<u>11.0</u>	<u>1,225,318</u>	<u>7,099</u>
TOTAL	9,974.1	4.9	\$30,238,718	\$ 3,032

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

(b) Field Compressor Stations - Average investment in field compressor stations amounts to approximately \$100 per horsepower as compared to an average investment of \$130 per horsepower in transmission compressor stations.

Figure 4



The lower cost of field compressor stations reflects the more temporary character of field station installations and a generally smaller investment in auxiliary facilities.

In Figure 4 are shown by means of bars of varying heights the various percentages of the total capacity represented falling within specified ranges of costs per horsepower. This information

is shown cumulatively in the curve appearing in the figure. Table 6 contains the data used in the preparation of Figure 4. For convenience, data on stations costing less than \$60 per horsepower and more than \$160 per horsepower are omitted from the figure.

It will be observed that by far the most generally prevailing costs are between \$80 and \$100 per horsepower. In excess of 80% of the total capacity is represented in this interval. Referring to the cumulative curve, it will be noted that the median cost per horsepower is approximately \$90 and that costs in the central 50% of the data range from approximately \$85 per horsepower to \$95 per horsepower.

As in the case of transmission compressor stations, wide variations in unit costs of field compressor stations are found at the extremes of the frequency distribution. These extreme costs are generally the result of construction conditions analogous to those effecting similar variations in unit costs of transmission compressor stations.

This study is based upon data reported for 28 field compressor stations constituting an investment on the books of the reporting companies in excess of \$2,800,000. Total rated horsepower of all driving units of these stations is approximately 29,000 horsepower. The principal reason for the small number of stations represented in this study is that pressures existing in wells operated by reporting companies are, in most cases, sufficient to propel the gas through gathering lines to main line compressor stations.

TABLE 6

FIELD COMPRESSOR STATIONS
FREQUENCY DISTRIBUTION ACCORDING TO CONSTRUCTION COST
PER RATED HORSEPOWER

INTERVAL DOLLARS PER RATED HP	NUMBER OF STATIONS	TOTAL BOOK COST EXCLUSIVE OF LAND	TOTAL RATED HORSEPOWER OF STATIONS		
			AMOUNT	PERCENT OF TOTAL	CUMULATIVE PERCENT
40 - 60	3	\$ 15,362	275	0.9	0.9
61 - 80	4	43,784	603	2.1	3.0
81 - 100	7	2,089,513	23,468	81.0	84.0
101 - 120	4	166,542	1,590	5.5	89.5
121 - 140	3	121,882	995	3.4	92.9
141 - 160	3	62,946	410	1.4	94.3
161 - 180	1	6,799	40	0.1	94.4
181 - 200	1	229,543	1,260	4.4	98.8
201 - 300	2	88,870	350	1.2	100.0
TOTAL	28	\$2,824,211	28,991	100.0	

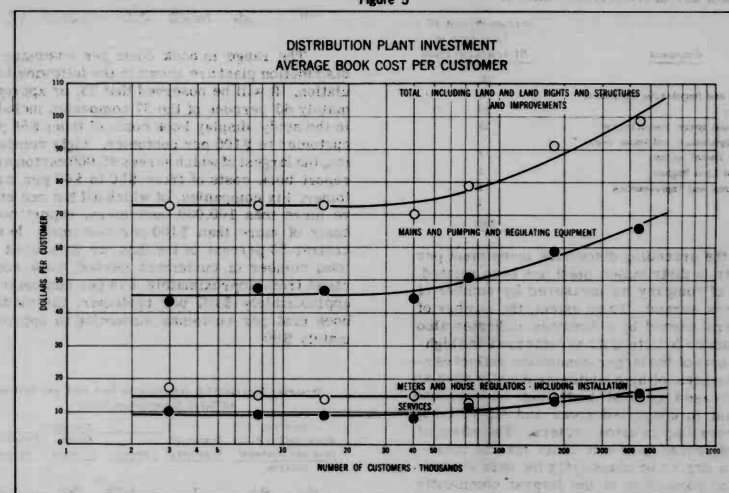
NATURAL GAS COMPANY PLANT INVESTMENT UNITS

SECTION 3
DISTRIBUTION PLANT INVESTMENT

Average investment in distribution plant ranges from approximately \$70 per customer for small companies serving rural areas and towns to approximately \$120 per customer for large companies serving metropolitan areas only. The effects of size of company, as measured by num-

highest average costs per customer. Because of the high proportion of the total cost of distribution plant represented by the cost of mains and services, total unit costs also display marked increases as the number of customers exceed 30,000. For example, reading from the figure, the average total cost of distribution plant of companies serving from 2,000 to 30,000 customers

Figure 5



ber of customers served, and of customer density, as measured by size of community served, upon investment per customer in distribution plant are discussed below.

In Figure 5 are shown, for the principal components of distribution plant and for total distribution plant, average book costs per customer in relation to number of customers served. Table 7 contains the data used in preparation of the figure.

Referring to Figure 5, it will be observed that average book costs per customer vary only slightly among companies serving from 2,000 to 30,000 customers. Beyond 30,000 customers there is a progressive increase in unit costs of mains and services as the number of customers increases, the largest companies displaying the

is approximately \$73 per customer. For companies serving 100,000 customers, the average unit cost is approximately \$80, and for companies serving 500,000 customers, the average unit cost is approximately \$103. Average unit costs of the principal components of distribution plant are shown in the following tabulation derived from the several curves in the figure:

Average Book Costs per Customer

No. of Customers	Mains and Pumping and Regulating Equipment	Meters and House Regulators	Services	Land Structures and Other	Total
5,000	\$46	\$15	\$9	\$3	\$73
10,000	46	15	9	3	73
50,000	47	15	10	3	75
100,000	51	15	11	3	80
250,000	60	15	14	3	92
500,000	66	15	17	3	103

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

Average percentage relationships between component costs of distribution plant and total cost of distribution plant are shown in the following tabulation. It will be noted that the cost of mains, services and meters represents on the average more than 90 percent of the total cost of distribution plant and that the cost of mains only represents in excess of 60 percent of total cost. These data are derived from Table 7.

Component	Average Percent of Total Cost of Distribution Plant
Mains	60
Pumping and Regulating Equipment	3
Services	16
Meters and Meter Installation	15
House Regulators and House Regulator Installation	1
Land and Land Rights	1
Structures and Improvements	1
Other	1
	100

In the preceding discussion investment per customer in distribution plant has been related to size of company as measured by number of customers served. To an extent, the number of customers served by a company indicates also the customer density of its service area and higher unit costs of the larger companies reflect certain influences of high customer density such as the increased cost of installing underground equipment in congested areas and higher labor costs prevailing in urban centers. The effect of these influences upon unit costs may be measured to a degree by classifying the data according to the population of the largest community served by each company. As shown in the following tabulation, it is found that companies serving the smallest communities display the lowest average investment per customer in distribution plant. As the population of the largest community served increases, average investment per customer also increases. Highest average investment per customer is displayed by companies serving only communities of 100,000 population and over, although the average number of customers of these companies is less than that of other large companies serving both small and large communities.

Average Book Cost per Customer

Population of Largest Community Served	Number of Companies	Customers Served	Cost of Distribution Plant Report Per Customer
Up to 2,500	4	34,000	\$ 204,217
Up to 10,000	8	20,004	\$ 134,137
Up to 100,000	10	400,101	\$ 20,440,100
More than 100,000	10	5,978,104	\$ 217,000,000
All Communities	32	6,432,209	\$ 20,320,000
More Than 100,000	10	5,978,104	\$ 217,000,000
Total	37	6,432,209	\$ 20,320,000

The range in book costs per customer of distribution plant are shown in the following tabulation. It will be observed that 23, or approximately 60 percent of the 37 companies included in the study, display book costs of from \$60 per customer to \$100 per customer. Eight companies, the largest of which serves 45,000 customers, report book costs of from \$50 to \$60 per customer. Six companies, of which all but one serve more than 100,000 customers, report book costs of more than \$100 per customer. In the central 50 percent of the data, as measured by total number of customers served, book costs range from approximately \$75 per customer to approximately \$105 per customer, the median book cost per customer amounting to approximately \$90.

Frequency Distribution According to Book Cost per Customer of Total Distribution Plant

Interval Distribution Plant Cost per Customer Dollars	Number of Companies	Customers Served	Percent of Total	Cumulative Percent
40.1 - 50.0	1	6,902	0.2	0.2
50.1 - 60.0	7	246,314	11.0	11.2
60.1 - 70.0	4	181,801	4.9	16.0
70.1 - 80.0	7	508,128	17.9	33.9
80.1 - 90.0	10	654,608	30.9	64.7
90.1 - 100.0	2	35,000	1.1	65.8
100.1 - 110.0	2	770,000	24.0	89.8
110.1 - 120.0	1	112,110	2.5	92.3
120.1 - 130.0	2	205,001	16.1	100.0
Total	37	2,165,465	100.0	

NATURAL GAS COMPANY PLANT INVESTMENT UNITS

This study is based upon the reports of 37 companies having a combined total of approximately 3,100,000 customers. The combined in-

vestment in total distribution plant of these companies amounts to approximately \$288,000,000.

TABLE 7
DISTRIBUTION PLANT INVESTMENT
AVERAGE BOOK COST PER CUSTOMER

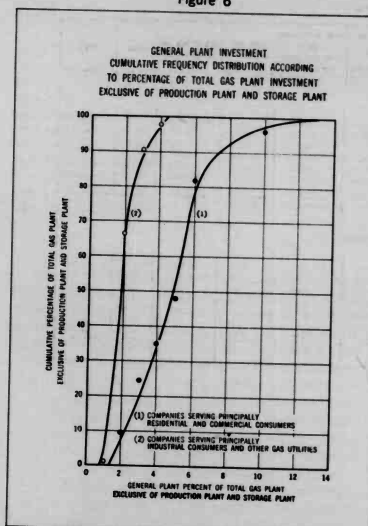
INTERVAL NO. OF CUSTOMERS (Thousands)	NUMBER OF COMPANIES	CUSTOMERS NUMBER PER COMPANY	MAINS	PUMPING AND REGULATING EQUIPMENT	SERVICES	METERS AND METER INSTALLATIONS	HOUSE REGULATORS AND HOUSE REGULATOR INSTALLATIONS	LAND AND LAND RIGHTS	STRUCTURES AND IMPROVEMENTS	OTHER	TOTAL
TOTAL BOOK COST											
0.0 - 5.0	7	20,985	2,990	\$ 874,011	\$ 44,567	\$ 230,645	\$ 302,340	\$ 42,640	\$ 13,301	\$ 20,020	\$ 4,501
5.1 - 10.0	7	53,731	7,474	2,423,446	133,726	517,153	740,812	52,931	20,042	34,292	10,684
10.1 - 25.0	4	43,843	15,844	2,633,582	130,290	573,021	845,313	40,156	64,097	137,631	40,902
25.1 - 50.0	5	204,281	40,454	9,462,773	387,204	1,686,010	2,740,130	337,447	307,144	356,000	85,200
50.1 - 100.0	5	343,970	72,794	17,947,459	564,314	4,812,249	4,485,714	99,301	354,183	644,573	186,161
100.1 - 250.0	4	1,086,430	181,302	61,354,700	2,746,748	14,830,713	14,428,342	582,922	405,884	1,222,495	195,623
OVER 250.0	2	1,304,443	452,140	80,919,034	4,100,448	21,112,004	18,940,119	1,339,044	1,131,693	2,051,222	339,624
TOTAL	37	3,109,465	65,121	119,115,007	\$9,487,697	\$49,311,023	\$44,935,775	\$2,305,125	\$2,096,490	\$4,397,207	\$863,147
AVERAGE BOOK COST PER CUSTOMER											
0.0 - 5.0	7	20,985	2,990	\$ 41.75	\$ 2.14	\$ 10.04	\$ 14.41	\$ 2.09	\$ 0.64	\$ 0.94	\$ 0.22
5.1 - 10.0	7	53,731	7,474	45.30	2.49	9.47	13.79	0.99	0.37	0.64	0.20
10.1 - 25.0	4	43,843	15,844	44.65	2.06	9.03	13.32	0.64	1.01	2.17	0.64
25.1 - 50.0	5	204,281	40,454	42.80	1.90	8.30	13.53	1.45	0.52	1.44	0.42
50.1 - 100.0	5	343,970	72,794	49.37	1.63	12.12	12.33	0.27	0.93	1.39	0.51
100.1 - 250.0	4	1,086,430	181,302	56.47	2.53	15.49	15.12	0.54	0.37	1.12	0.18
OVER 250.0	2	1,304,443	452,140	62.65	3.40	15.56	13.90	0.98	0.83	1.48	0.25
TOTAL	37	3,109,465	65,121	\$ 54.87	\$ 2.76	\$ 14.39	\$ 14.14	\$ 0.80	\$ 0.66	\$ 1.40	\$ 0.27

SECTION 4

GENERAL PLANT INVESTMENT

Because it is impractical to relate general plant investment to any specific physical quantity, it has been related to total investment in gas plant, less investment in production plant and storage plant. Investments in production and

Figure 6



storage facilities are excluded from total gas plant investments because, while the amount invested in general plant is not materially affected by the investments in such facilities, the ratio of general plant to total gas plant would be affected considerably by the difference in relative investment in production and storage facilities of producing and purchasing companies. By the exclusion of production and storage plant investment, it is believed that the derived proportions of general plant investment to balances of gas plant investment are reasonably comparable among producing and purchasing companies.

For companies which sell principally to residential and commercial consumers, the av-

erage ratio of investment in general plant to total investment in gas plant, exclusive of investment in production plant and storage plant, is approximately five percent. For companies which sell chiefly to industrial consumers and other gas utilities, such ratio is approximately only two percent. The difference in the proportionate amount of investment in general plant between these two types of companies reflects, among other factors, the necessarily larger investment in facilities used in maintaining customer contacts by companies serving a considerable number of consumers. Among such facilities usually included in general plant are office buildings and equipment devoted to carrying on customer accounting and service activities and the housing of sales promotion activities.

In Figure 6, there are shown, cumulatively, the percentages of the total investments in gas plant, less investments in production plant and storage plant, falling within designated ranges of the ratio discussed. Companies classified as serving principally industrial consumers and other gas utilities furnish virtually no residential or commercial service. Residential and commercial customers of companies classified as serving principally these types of consumers constitute at least 90 percent of the total number of customers served by each such company. Table 8 contains the data used in preparation of the figure.

Referring to Figure 6, it will be noted that, for companies serving principally residential and commercial consumers, the median ratio of general plant to total gas plant, exclusive of production and storage plant, is approximately 4.8 percent. In the central 50 percent of the data, ratios range from approximately 3.4 percent to 5.8 percent. Wide variations from the median ratio, as shown at the extremes of the figure, are due principally to differences in company practices with respect to the housing of customer accounting and service activities and general office activities. In instances where the greater part of space used for such activities is rented from others, individual ratios are, of course, quite low. Where companies have invested a considerable amount in general office building, the cost of which is included in utility plant, and have provided extensive facilities for furnishing customer service, individual ratios are generally high. Classification of the data according to size of company indicates that very small companies

display ratios somewhat lower than average and very large companies display ratios somewhat higher than average. However, in general, size of company appears to exert little influence upon relative investment in general plant.

With respect to companies serving principally industrial consumers and other gas utilities, the median ratio of general plant to gas plant, exclusive of production plant and storage plant, is approximately 1.8 percent. In the central 50 percent of the data, ratios range from approximately 1.4 percent to 2.2 percent.

General plant includes such property as general office land and structures, other land and structures used for general purposes, office furniture and equipment, transportation equipment, communication equipment, tools and work equipment, and other miscellaneous equipment not assignable to specific operations.

This study is based upon the reports of 55 companies. The combined book cost of general plant of these companies is approximately \$37,000,000. Combined book cost of total gas plant, exclusive of book cost of production plant and storage plant is approximately \$913,000,000.

TABLE 8

GENERAL PLANT INVESTMENT
FREQUENCY DISTRIBUTION ACCORDING TO PERCENTAGE OF
TOTAL GAS PLANT INVESTMENT EXCLUSIVE OF INVESTMENT IN
PRODUCTION PLANT AND STORAGE PLANT

INTERVAL GENERAL PLANT PERCENT OF GAS PLANT*	NUMBER OF COMPANIES	GENERAL PLANT - BOOK COST		GAS PLANT* - BOOK COST		
		AMOUNT	PERCENT OF GAS PLANT*	AMOUNT	PERCENT OF TOTAL	CUMULATIVE PERCENT
COMPANIES SERVING PRINCIPALLY RESIDENTIAL AND COMMERCIAL CONSUMERS						
1.1 - 2.0	9	\$ 933,231	1.6	\$ 57,212,659	9.6	9.6
2.1 - 3.0	8	2,214,020	2.5	89,673,265	15.0	24.6
3.1 - 4.0	5	2,330,722	3.8	62,027,995	10.4	35.0
4.1 - 5.0	8	3,465,292	4.5	77,069,170	12.9	47.9
5.1 - 6.0	6	10,913,622	5.4	201,319,752	33.8	81.7
9.1 - 10.0	2	8,122,709	9.5	85,437,384	14.3	96.0
12.1 - 13.0	1	3,056,579	12.7	24,008,605	4.0	100.0
TOTAL	39	\$31,014,175	5.2	\$596,748,830	100.0	
COMPANIES SERVING PRINCIPALLY INDUSTRIAL CONSUMERS AND OTHER GAS UTILITIES						
0.0 - 1.0	1	\$ 23,669	0.7	\$ 3,600,808	1.1	1.1
1.1 - 2.0	10	3,015,472	1.5	207,300,573	65.5	66.6
2.1 - 3.0	3	1,798,082	2.4	75,855,159	24.0	90.6
3.1 - 4.0	1	782,993	3.4	23,262,068	7.3	97.9
4.1 - 5.0	1	278,747	4.2	6,652,867	2.1	100.0
TOTAL	16	\$ 5,898,923	1.9	\$316,671,475	100.0	

*Total Gas Plant Exclusive of Production Plant and Storage Plant.

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